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THE EFFECT OF VARYING THE CONCENTRATIONS AND THE LIME-TO-COPPER RATIO OF BORDEAUX MIXTURE IN POTATO SPRAYING

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The effect on potato yields of the total amounts of copper sulfate applied as bordeaux mixture in western New York was shown by F. M. Blodgett and coworkers[1] in a recent article in the Potato Journal. Similar experiments by the writer in 1933 confirmed these earlier results. Approximately 75 pounds of $CuSO_4$ per acre per season, gave the maximum and the most profitable yields of Rural Russet potatoes under conditions at Pittsford, N. Y. The yield (table 1) are the averages in bushels per acre for 12 replications of 1/100 acre plots. The differences are all highly significant.

TABLE 1.—*Concentration Experiment*—1933 *at* 400 *pounds pressure*

Formula	Gals. per Acre per Application	No. of Applications	Total Amount of Copper Sulfate per Acre per season	*Yields in Bushels per Acre* 1932	1933
Unsprayed	0	0	0.0 lbs.	213.4	174.44
2-2-50*	100	6	24.0 "	268.7	237.2
2-2-50	154	6	36.9 "	283.8	260.9
4-4-50	100	6	48.0 "	311.4	281.3
4-4-50	154	6	73.9 "	329.3	294.6
8-8-50	100	6	96.0 "	303.4	285.6
8-8-50	154	6	144.8 "	299.3	274.7

*Refers to calcium oxide.

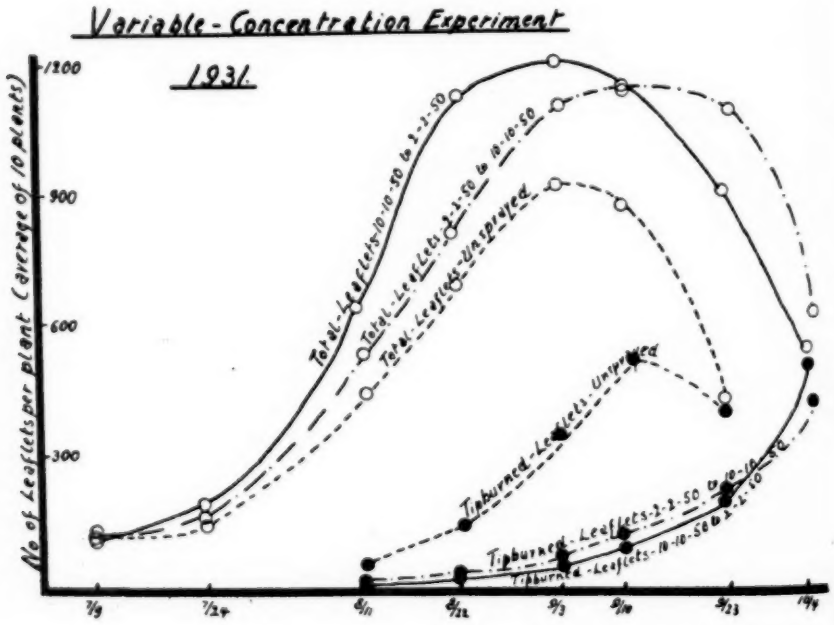
It was found that the various treatments had a decided effect on foliage development, tuber set, retention and development of tubers, as well as their final shape and size at harvesting time.

Foliage of the plants in the untreated plots showed a greater total weight than that of the plants of treatments which had received the first application. These differences did not prove to be significant.

After the second application, plants treated with a high copper concentration showed a substantially larger foliage development than the plants of treatments receiving small amounts of copper or no copper. All the differences in foliage weights in the high copper treatments remained significantly higher throughout the remainder of the season. These differences were practically not affected by insect pests and late blight, there being only a slight infestation of the former and the latter being absent.

This phenomenon of the response to high copper concentration at the beginning of the season and its probable effect on tuber production led to further investigations. Experiments started in 1931 may be described as follows: Instead of applying the 75 pounds of copper sulfate at equal rates such as a 5-5-50 for each application, one series of plots received at the beginning of the season a bordeaux mixture of a high formula such as a 12-12-50 and its strength was reduced with each subsequent application; another series received these formula in the reverse order, starting low and increasing the strength; while in the third series a 5-5-50 was applied throughout the season. The effect of the treatments on the growth of the plants was studied. The experiments for the three years may be summarized as follows:

FIG. I



The total number of leaflets per plant as well as the total weight per plant (averages of forty plants) showed a substantial increase for plants treated with the high copper concentration at the beginning of the season. Plants in this treatment reached an earlier maximum in their growth. Plants of the reverse treatments tended to keep the foliage green longer in the season, while those of plots treated with a 5-5-50 throughout the season took a middle course. The total as well as tip-burned leaflets of the various treatments for 1931 (figure 1) may serve to illustrate this point. The ordinates give the average number of leaflets per plant and the abscissae show the dates when counts were made. In the high to low concentration plots there was a larger increase in the number of leaflets per plant, and an earlier total maximum. A distinct maximum, about ten to fourteen days later occurred in the low

TABLE 2.—*Variable Concentration Experiment—1933 at 400 lbs. pressure*
Application table showing treatments and yields

Application	No 1	No. 2	No. 3	No. 4	No. 5	Unsprayed
	*	*	*	*	*	
1st	12-12-50	1- 1-50	5-2 1/2-50	10-5-50	5-5-50	0
2nd	9- 9-50	2- 2-50	12-2 1/2-50	8-4-50	5-5-50	0
3rd	6- 6-50	3- 3-50	8-2 -50	6-3-50	5-5-50	0
4th	4- 4-50	4- 4-50	6-4 -50	4-2-50	5-5-50	0
5th	3- 3-50	6- 6-50	3-1 -50	3-1 1/2-50	5-5-50	0
6th	2- 2-50	9- 9-50	2- 1/2-50	3-1 1/2-50	5-5-50	0
7th	1- 1-50	12-12-50	1- 1/2-50	3-1 1/2-50	5-5-50	0
Yields in bu. per acre—1933						
	304.9	270.5	309.3	299.9	282.1	212.1
Yields in bu. per acre—1932						
	284.2	255.3	....	....	261.2	179.5
Yields in bu. per acre—1931						
	308.3	278.7	....	....	....	230.6

*Refers to calcium oxide.

to high concentration curve. That the differences in these two growth curves are slightly or not at all affected by the number of tipburned leaflets caused by leafhoppers, flea-beetles, drought, or physiological factors is shown by the small number of injured leaflets at the time of greatest foliage development. Furthermore, the plants in plots receiving the low to high concentrations remained green later in the season. Average total green weights per plant taken at intervals during the season showed in general the same relationship between the treatments. These differences in growth, total leaflets, and foliage weight per plant occurred for three seasons.

For all three years, plants in the treatments receiving the high concentrations at the beginning of the season and decreasing strength with advance of season (Treatment No. 1 of table 2) out-yielded the plants of plots receiving treatments of the reverse order (Treatment No. 2) by about thirty bushels per acre, and out-yielded the plants receiving the 5-5-50 strength throughout the season (Treatment No. 5) by about twenty-four bushels. The average total yields of the various treatments are for 24 one hundredths of an acre plots in each case, and the differences are all highly significant.

It was not only a question of obtaining the highest yields, but how the various treatments affect the final grade or shape of the tubers. An example of tuber weights and gradings for September 28, 1932, is given for the variable concentration experiment (table 3). A relatively uni-

TABLE 3.—*Comparing yields and size grades of tubers in the variable concentration experiment September 28, 1932*

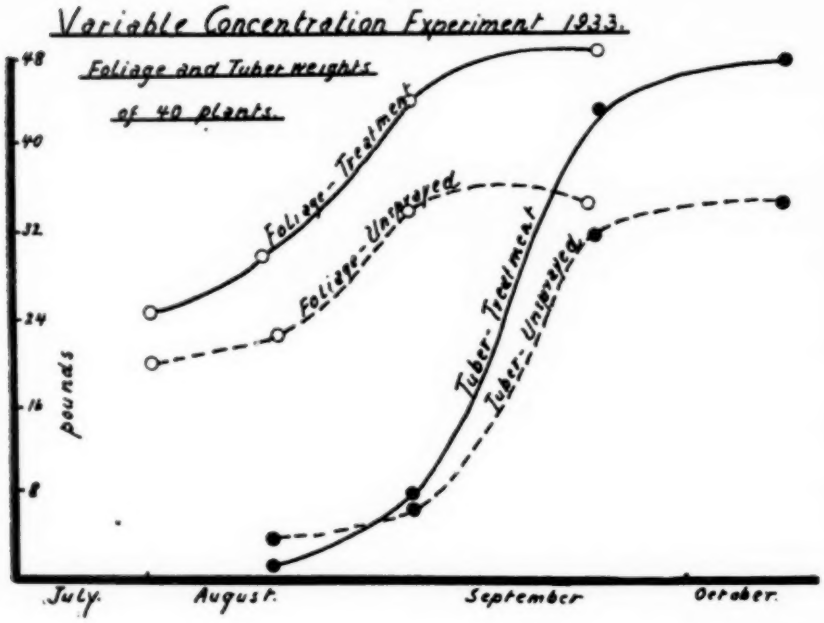
	Treatments			
	Check	12-12-50 to 1-1-50	1-1-50 to 12-12-50	6-6-50 straight
	Total yields of 40 plants in pounds			
	35.12	54.5	45.7	46.6
Size	Tubers in different size classes			
1-5 cm	Per cent 14	Per cent 11	Per cent 23	Per cent 17
5-11 cm	78	80	63	69
Above 11 cm	8	9	14	14

form tuber size in the case of the check is to be noted. The total weights are too small, however, to give promising final yields. It is of special interest to notice the excellent grade of tubers in the 12-12-50 to 1-1-50 treatment as compared with the 1-1-50 to 12-12-50, wholly aside from the higher yields in the former.

Studies were made of the effect on tuber setting, retention, and tuber development in relation to the foliage in an attempt to find some of the underlying reasons and explain the differences obtained in yields. Does the application of copper increase the set of the tubers per hill? Tubers of pea size and larger only were counted because of difficulties encountered in the study of initial setting of tubers under field conditions on a large scale. Any method or practice in the cultivation of potatoes, which succeeds in retaining at least the larger part of the tubers set, will give larger yields. That this can be accomplished with bordeaux mixture seems to be the case. There seems to be no great difference in the number of tubers per hill at the time the first counts were made. With the advance of the season it was found that the total number of tubers per hill decreased regardless of treatment. However, with plants receiving the high concentration at the beginning of the season, the retention of tubers was better than for those receiving the reverse schedule or no fungicides. All differences in tuber set, and in retention of tubers proved to be significant. It was found that early in the season the enlargement of tubers was greater in the untreated plots and on those receiving low copper concentrations. Shortly after tuber setting, tubers of the check plants were about three to four times larger than those in the high concentration plots. With the advancement of the season, however, the difference in the total as well as the individual tuber weights shifted in favor of the treatments receiving the high concentration at the beginning. In general, this tendency holds true in other comparative experiments. The assumption that the higher final yields, in certain treatments, may be due to a larger individual tuber weight does not hold entirely but must be explained rather on a basis of a larger number of tubers set per hill.

The development of the foliage as well as the tubers takes place in a typical S-curve (fig. 2). There is a substantially larger increase in the foliage weight of the treated plants. The increase of tuber weight is largest in the check plants in the earlier part of the season, but soon the treatment takes the lead. Furthermore, the greatest tuber enlargement or increase takes place at the time the foliage weight reaches its maximum, and the entire period of rapid enlargement of tubers is relatively short. After this the rate of development slows down and there

FIG. II



is little gain from leaving the potatoes in the soil except to obtain better maturity.

In another type of experiment it was found that if the lime content of the mixture was lowered, the yields were increased although equal total amounts of copper were used throughout the season (table 4). The yields in bushels per acre for each treatment are the averages for 24 one hundredths acre plots. By decreasing the amount of lime in the bordeaux, the yields were increased almost in a straight line with the

TABLE 4.—*Yields in Copper—Lime Ratio Experiment*

Formula a. Lbs. Copper Sulfate b. Lbs. Calcium oxide c. Gallons water	No. of Applications	Total Amount of Copper sulfate per Acre per Season	Total Amount of Hydrated lime per Acre per Season	Yields in Bushel per Acre	
				1932	1933
a. b. c.					
Unsprayed	0	0.0 lbs.	0.0 lbs.	171.1	112.6
5 - 7½-50	6	60.0 "	119.4 "	243.9	206.2
5 - 5 -50	6	60.0 "	79.8 "	247.6	220.2
5 - 2½-50	6	60.0 "	39.96 "	254.7	238.0
5 - 1 -50	6	60.0 "	12.72 "	270.1	237.1

exception of the yields in the 5-1-50 plots of 1933. Differences between the treatments are significant, with the exception of those between the 5-2 1/2-50 and the 5-1-50 treatments of 1933.

This tendency to increase yields by lowering the lime content in the bordeaux mixture partially explains the increase in yields obtained when magnesium lime was used, since it should be recalled that this lime is only 2/3 as active as the calcium lime. Furthermore, the combination of the factors of the lower lime content together with a high concentration at the beginning of the season proved very effective in increasing the yields. (Table 2—treatments Nos. 3 and 4).

SUMMARY

Additional experiments for 1933 confirmed previous results that maximum yields were obtained, for western New York with Russet Rural potatoes by the use of approximately 75 pounds of copper sulfate, per acre per season, in the form of bordeaux mixture applied at 400 pounds pressure.

The application of the larger part of this amount early in the season had a decided stimulating effect on the plants resulting in an earlier maximum in their development, a retention of a larger number of tubers per hill, a larger total tuber weight, and more uniform tubers.

Decreasing the lime content of the bordeaux mixture increased the yield. Experiments this year showed that these changes could be combined in one schedule with beneficial results.

(1) F. M. Blodgett, E. O. Mader, O. D. Burke and R. B. McCormack New Developments in Potato Spraying. American Potato Journal 10:5:79-88. 1932.

GREEN MANURES IN POTATO ROTATIONS

A PRELIMINARY REPORT[1]

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On heavy soils, such as the silt loams and clay loams of northeastern Ohio, the chief purpose of green manure crops in potato rotations is to improve the aeration of the soil. This assertion is based upon two small experiments at Wooster:

1. In an old three-year-rotation, on plots which have never been manured, and the only supply of organic matter has been the crop

[1]Read at the annual meeting of the Empire State Potato Club, Rochester, New York, Jan. 25, 1934.

residues and a clover sod, the addition of ordinary sand distinctly increased the yield. Fertilizer alone in 1932 gave a yield of 212 bushels per acre; the addition of about an inch of sand, well mixed in the soil, raised the yield to 290 bushels, an increase of 78 bushels per acre.

2. On a well-manured field, ordinary tiles were placed five inches deep directly under the potato rows, with the tile lines open at both ends to insure circulation of air throughout them. The potatoes were planted almost immediately on top of the tiles. The check rows, without the tile, yielded at the rate of 347 bushels, the tiled rows 415 bushels per acre. This was during the dry season of 1933.

Evidently these soils are distinctly improved by any procedure which increases the aeration.

Insect and Disease Control

In planning potato rotations, other important considerations are the elimination of scab, scab gnat, wire worms and grub worms. Our present information regarding the possibility of controlling these soil pests is, briefly, as follows:

1. Scab is caused by a bacterium that does not thrive at pH of 5.5 or lower. Scab gnat injury usually follows scab, the gnat working into the tuber at the scab lesions. Hence by keeping potato soils distinctly acid, scab and scab gnat are largely controlled.

2. The adult of the wire worm lays eggs during late May and June, according to findings of entomologists to date. The eggs are deposited in sod, or in small grain. Wherever there is any danger from wire worms, the potato rotation should not have sod, wheat, oats or rye from the middle of May to the last of June. This rule for control also applies to grub worms.

These findings mean that many of the old standard two-year and three-year rotations in which potatoes were followed by wheat or oats, with legumes sown in them, are to be ruled out, because the wheat and oats afford cover for wire worms and because the use of lime to insure legumes brings in a danger from scab.

Experiments with Corn and Buckwheat as Green Manure

Experiments with non-legumes as green manures in a two-year rotation were started at Wooster in 1930. The area selected for this work had never been manured nor limed and was in rather poor physical condition for potatoes. The original test was a comparison of corn and buckwheat, to be plowed down, with soy beans and sweet clover. The entire area was lightly limed to insure good crops of the legumes. The initial experiment was not an attempt to control scab and wire

worms, but was designed to find out whether corn and buckwheat could be used as green manures for potatoes as successfully as sweet clover and soy beans.

The soil being rather poor, it was deemed advisable to use some nitrogen fertilizer to get large yields of the non-legumes. At the outset 400 pounds per acre of sulphate of ammonia were applied to the corn and buckwheat, and on certain plots the rye following these was similarly fertilized. The aim was to apply almost as much nitrogen as these crops could absorb, assuming that there was very little reserve in the soil, and not relying upon fixation of atmospheric nitrogen by the soil organisms.

The rye following the potatoes was plowed when less than two feet tall. The corn was similar to silage. The buckwheat was sown at the same time the corn was planted, then was disked under in midsummer and a second crop planted. The corn, soy beans, and second crop of buckwheat were all plowed under in late September and rye sown. In order to obtain a large amount of coarse organic matter from the rye, it was allowed to become four or five feet tall. The past two seasons, the rye has dried out the soil and interfered with capillarity to the distinct detriment of the potato crop.

The results to date are summarized in table 1. The amount of green matter plowed under was determined by square yard samples, which were dried for analysis, and, therefore, the amounts are reported in the table as "dry matter."

TABLE 1.—*Yield of green manures and potatoes at Wooster. 3-year averages.*

Green Manure Crops	Potatoes, Bus. per acre	Approximate Composition of Green Manures Lbs. per Acre Dry Matter	Nitrogen
Sweet clover	202	6000	150
Rye		2000	60
Soy beans		4500	117
Rye		4000	80
Total	233	10500	257
Rye		2000	60
Buckwheat		3000	66
Buckwheat		2500	60
Rye		4000	80
Total	249	11500	266
Rye		2000	60
Corn		10000	100
Rye		4000	80
Total	258	16000	240

The results show that larger amounts of coarse organic matter can be obtained by plowing under corn with two crops of rye than by any of the other systems. The yields of potatoes have responded to the larger amounts of organic matter.

The Use of Nitrogen Fertilizer with Non-Legumes

At the outset, as mentioned above, large amounts of nitrogen fertilizer were applied to the corn and the rye. The total was 800 pounds of sulphate of ammonia per acre, approximately 160 pounds of nitrogen. In addition, the potatoes received 1000 pounds of 4-10-10 per acre, which contained 40 pounds of nitrogen. A 250 bushel crop of potatoes removes less than 60 pounds of nitrogen.

During the course of the experiment it has become evident that these amounts of fertilizer are excessive. Part of the rye following the corn has not been fertilized at all, and has given very nearly the same growth and the same chemical composition as that which received 400 pounds per acre of sulphate of ammonia. It thus appears that if the corn is well fertilized, the rye needs only a little. The seasons, however, have been dry, and I hesitate to draw any definite recommendations from such seasons.

Some additional experiments have been started to add further information to the question of handling corn and rye as green manures. It has been found that the nitrogen fertilizer may be applied very effectively to the rye in early spring. This means that it is possible to judge from the growth of rye in the fall whether or not it needs some nitrogen fertilizer. On rye which made a poor growth over winter, applications of 200 pounds per acre of sulphate of ammonia increased the yield 20 per cent or more and distinctly increased the nitrogen content. On well manured soil, on the other hand, the rye has grown rapidly, and not responded sufficiently to sulphate of ammonia to justify the expense.

The corn, during the past two seasons, has distinctly benefited from the nitrogen fertilizer on plots that were not manured. Sulphate of ammonia at the rate of 400 pounds per acre has nearly doubled the yield of dry matter. The effect on the corn is one of increasing growth; the percentage of nitrogen in the dry matter has not been appreciably increased.

The conclusion is that the amount of nitrogen needed will vary widely with the fertility of the soil. To build up a poor soil rapidly by the use of non-legumes, it would seem from the data at hand that 400 pounds of sulphate of ammonia per acre would be needed by the

corn and 200 pounds by the rye that follows, while on rich, black soil none at all would be needed.

Handling Rye as a Green Manure

Rye usually thrives following potatoes. For this reason, no experiments have been conducted on adding fertilizer to this crop. Where corn is to be grown, it seems to be necessary to plow the rye by early May. The proper preparation of soil for corn, following potatoes, is a special problem for which I do not have an answer. The corn crops at Wooster have not been so large following potatoes as on clover sods, even though the rye was plowed early and an abundance of fertilizer was applied.

The proper stage for plowing under rye for potatoes varies with the type of soil. On very heavy soils, such as those at the Northeastern Test Farm near Cleveland, tall rye is usually more beneficial than detrimental. At Wooster, on silt loam, rye more than four feet tall has distinctly retarded the early growth of potatoes, and even though it appears beneficial toward the close of the season, the evidence to date shows that rye should not be more than three feet tall. On sandy soils, the harmful effects of drying the soil in the spring and interfering with capillarity during the summer would probably be more pronounced, hence the rye should be plowed at an earlier stage.

In this connection, it should be added that where soil has been dried out by tall rye, that small whole potatoes or properly healed cut seed has been used and good stands obtained. With freshly cut seed, however, the losses may be considerable in very dry soil.

There is an added risk in allowing rye to grow beyond the middle of May in that it may attract wire worms. As entomologists determine more definitely the dates at which the wire worm beetles start laying eggs, it will probably prove advisable to plow rye before that date.

Handling Corn as a Green Manure

Although in the initial experiment the corn was planted in rows like silage, it has since been found that larger amounts of green matter can be obtained by drilling it with a grain drill at the rate of about a bushel per acre.

Corn in late September is very easily cut up with a disk; it is easier to cut than soy beans. It can also be plowed under with a tractor without precutting. Large corn plowed under in the fall has not interfered in the least with the preparation of the soil the following spring.

Handling Buckwheat as a Green Manure

Buckwheat is a crop that does not produce seed during hot weather, but when cool weather comes produces seed in abundance. The spring crop, planted the middle of May, usually has no seeds if disked in the middle of July. The second crop, however, produces such a quantity that the seeds are a serious weed the following year in the potatoes. For this reason alone, buckwheat is ruled out as a practical green manure for late summer.

The spring crop grows rapidly, and is excellent for eradicating weeds, since weeds that survive the competition are killed by the disking in July. A satisfactory crop to follow the spring buckwheat has not yet been found. In the work at Wooster to date, other fall crops have done very poorly following buckwheat, even though the buckwheat was plowed under, and even when ample rains have ensued.

Green Manures for Sandy Soils

The Experiment Station has not yet conducted work with green manures for potatoes on sandy soils. From general considerations, however, it would seem that the use of coarse crops, such as tall corn, would not be advisable, as the coarse material would tend to increase the aeration to the point where moisture deficiency would be the limiting factor. To avoid this it may prove more satisfactory to grow two crops of corn, plowing the first in mid-July when about four feet tall, and immediately reseeding to corn. Corn when four feet tall has a nitrogen content of about 2 per cent, and rots rapidly in the soil. At Wooster a second crop planted in July has made excellent growth. By plowing under the corn when about four feet tall, and the rye when about two feet, all decompose rapidly and soon reach a humus stage where they presumably tend to retain moisture.

Conclusions

From the evidence at hand it seems to be a practical procedure to use non-legumes as green manures for potatoes. Non-legumes can be grown on soils at a pH of 5.5 or lower more successfully than legumes. A rotation can be arranged which, according to our present knowledge, will escape danger of wire worms and grubs.

The use of non-legumes, such as corn is advocated where legumes have failed to maintain the soil in proper physical condition, or where legumes do not thrive because of the soil reaction, or where wire worms have appeared because sod or small grains were part of the rotation.

SOME OBSERVATIONS ON THE SPROUTING HABITS OF POTATO TUBERS EXPOSED TO LOW TEMPERATURES.[1]

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Low temperature injuries to potato tubers constitute a difficult problem during the main shipping season which extends over a period approximately from October to January of each year. Dealers, commission agents, and transportation companies meet with great difficulties when handling potatoes in cold weather. Because of this climatic factor the farmer, through no fault of his own, frequently has the unfortunate experience of seeing his otherwise high grade seed potatoes rejected because of frost injury. Confronted with this difficult situation everybody concerned seeks dependable and definite advice on such important points as the temperature at which potatoes may be moved, the definition of frost injury, and its effect upon the potatoes.

In view of the widespread interest shown in the low temperature problem, and because of the necessity for enlightenment upon the subject as related to our local conditions, an effort has been made to investigate the principles associated with low temperature injuries. During the course of this work many striking observations were made on tuber sprout development, which, while incidental to the main problem, is described at this time as a matter of interest to those engaged in potato work.

PROCEDURE

During the month of February, 1932, Green Mountain and Irish Cobbler potatoes were removed from storage and exposed out of doors to low temperatures for periods of from five to sixty minutes, making twelve exposure tests at five minute increments for each temperature. Ten tubers were removed every five minutes and in this manner a total of one hundred and twenty tubers of each variety were exposed on their sides one layer thick and on a one-inch wire mesh frame and supported by four posts projecting two feet above the snow level. Because of the liability to temperature fluctuations for periods of more than one hour, longer exposures were not attempted. Air temperatures were determined by means of a maximum and minimum thermometer

1. Contribution from Division of Botany, Experimental Farms Branch, Ottawa, Ontario. Dominion Department of Agriculture, Ottawa, Ontario.
2. Plant Pathologist in charge, and Plant Disease Investigator, respectively.

located within a few feet of the exposure rack, and, in addition, tuber temperatures were ascertained with the aid of sharp-pointed meat thermometers stabbed into the tubers to a depth sufficient to cover the bulb until the termination of each exposure when the scale reading was accepted as the temperature of the tubers. For a period of twenty-four hours previous to making exposures the tubers were held in a modified storage with a temperature of approximately fifty degrees Fahrenheit. Upon the termination of each exposure the tubers under test were placed in paper bags, then returned to normal storage and after a period of 44 days removed for observation purposes. Because of the unusual sprouting tendencies exhibited by the potatoes subjected to the various exposures careful comparisons were made, using for check purposes tubers taken at random from the laboratory storage basement. It is to be expected that tests made under these uncontrollable conditions are open to question. Nevertheless, the actual findings are of considerable interest, leading possibly to practical significance.

Results

Because the temperature on most days was subject to frequent and rapid fluctuations it was impossible to follow out a systematic experimental plan. Consequently every effort was made to arrange the exposures for the days and under the conditions best adapted to making the tests, which, accordingly, were extended over the period from February 7, to February 20, inclusive. For the sake of uniformity in observations notes on the condition of the tubers were made 44 days after the exposure dates as shown in table 1.

TABLE 1.—*Frost exposures*

Date Exposed	Temperature in Degrees Fahr.	Examination Date
February 7	14°	March 23
" 9	17°, 18°, 19°, 20°, 21°	" 25
" 10	7°, 11°	" 26
" 11	20°	" 27
" 13	23°, 24°	" 29
" 14	26° 27°, 28°	" 30
" 16	15°, 16°	April 1
" 20	13°	" 5

The exposures made during a period of sixty minutes, at a constant temperature are shown in table 2.

TABLE 2.—*Frost exposures*

Variety: Irish Cobblers

Tuber Temperatures	Time in Minutes											
	5	10	15	20	25	30	35	40	45	50	55	60
	Air Temperature, 7° F.											
	46	44	38	33	33	30	30	29	29	29	29	29
	Air Temperature, 11° F.											
	46	44	42	38	32	30	30	29	29	29	29	29
	Air Temperature, 13° F.											
	44	44	43	40	40	36	36	34	34	32	32	32
	Air Temperature, 14° F.											
	44	44	40	40	38	32	32	32	30	30	30	30
	Air Temperature, 15° F.											
	48	44	38	35	32	32	30	29	29	29	..	..

In reference to table 2 it will be noted that constant air temperatures were obtained as follows: 7° F., 11° F., 13° F., 14° F., and 15° F. In table 3 are given the exposures and tuber temperatures for the higher air temperatures which were constant for short periods only.

It was readily noted that tubers exposed to frost for short periods produced sprouts more rapidly than was the case with tubers held in ordinary storage. At an air temperature of 28° F. tubers exposed for 60 minutes produced sprouts of slightly greater vigor and size than did the unexposed check tubers. In the former case interior injury was indicated by slight ring necrosis in twenty per cent of the tubers. With the slightly lower air temperature of 24°, however, and an exposure of 60 minutes, the sprouts were larger than those of the checks. At this temperature, 30 per cent of the tubers showed definite ring necrosis, combined with slight mottling. When exposed for 60 minutes at 13° F. sprouting was decidedly reduced, and 70 per cent of the tubers showed external frost spots while 80 per cent exhibited heavy ring necrosis with mottling and netting. At the slightly higher temperature of 14° F., tubers exposed for 30 minutes produced vigorous clustered sprouts to the extent of 80 per cent, due no doubt to injury inflicted upon the tender growing sprout tips when the exposure was made and further indicated by the injured tips of the well-developed sprouts. In this particular series of tests forty per cent of the tubers developed slight ring necrosis, the remaining sixty per cent being sound. Finally, at 11° F. definite injury to the sprouts was sustained at an exposure of 25 minutes. This treatment caused definite ring necrosis and blotching,

TABLE 3.—*Frost exposures*
Tuber temperatures in degrees Fahrenheit

Air Temperatures Degrees Fahrenheit	Exposures in Minutes											
	5	10	15	20	25	30	35	40	45	50	55	60
17°										29°	29°	29°
18°							30°	29°	29°			
19°					34°	31°						
20°		44°	40°	36°								
21°	48°											
23°	45°	45°										
24°			42°	41°	39°	37°	37°	35°	33°	33°	32°	32°
26°	46°	46°										
27°			45°	44°	42°	42°	38°					
28°								36°	34°	32°	32°	32°

as well as exterior spotting. In the five cases just referred to it is of interest to note that in each instance the temperature of the tubers at the conclusion of the exposures was 32° F., a fact of some significance to individuals concerned with the problem of deciding an issue on possible frost injury to potato shipments.

The series of tests with the temperature at 11° F. produced some developments of interest. Exposures of five minutes resulted in the rapid and uniform growth of vigorous sprouts. Forty per cent of the exposed tubers showed definite ring necrosis. In this instance the tuber temperature was 46° F. Exposed for a period of 15 minutes at 11° F. the tuber temperature was 42° F., growth was vigorous and rapid but lacked the uniformity which featured the five minute exposure. Otherwise, there were no visible differences. At the same temperature

(11° F.) but with an exposure of 40 minutes the temperature of the tubers was 29° F. Severe injury was apparent as indicated by an almost complete suppression of sprouts, together with exterior blemishes and heavy ring necrosis, blotching and coarse netting in all of the tubers. In this connection it is of interest that the tubers exposed for the same period of time (40 minutes) with the air temperature of 16° F. and cooled to 29° F. reacted in a strikingly similar manner, inasmuch as the sprouts were noticeably retarded and the tubers spotted. At this slightly higher temperature the various forms of necrosis, while present, were less marked.

Exposures for 5 minutes at 7° F. induced a tuber temperature of 46° F. and gave no indication that the potatoes were in any way adversely affected, the sprouts being vigorous and somewhat in advance of those on the check tubers. Tubers exposed for 15 minutes exhibited slow but vigorous sprout growth and, while there was no necrosis, 20 per cent of the tubers were found to be spotted. In accordance with expectation, prolonged exposures caused severe injury and at 30 minutes all of the tubers were practically destroyed.

In this statement no attempt is being made to correlate tuber temperature with the vigour of sprouts yet it is evident from our observations that when the tuber temperature drops to 32° F. or lower during exposure to frost, sprout growth is inhibited to the point of indicating injury to the tubers. On the other hand the sprouts from tubers in which the temperature was 45° F. following an exposure of 5 minutes in air temperatures of 23° F. and 27° F., were of the vigorous type. This condition, and the fact that the tuber temperature decreases with prolonged exposures is of practical significance on occasions when it is necessary to move potatoes during cold weather.

Summary

1. From a series of tests designed to study the reaction of potato tubers subjected to low temperatures it was clearly evident that sprouting tendencies were influenced very largely by the duration of the exposure.

2. At an air temperature of 24° F. tubers exposed for 60 minutes produced sprouts of slightly greater vigour and size than did the unexposed check tubers. Sprouting capacity, however, was affected adversely by exposures at lower temperatures.

3. Definite relationships were indicated with respect to length of sprouts and duration of exposure. In general it would appear that the longer exposures were detrimental, especially at the lower temperatures, thus, exposure at 11° F. for 25 minutes arrested sprout growth and caused necrosis and exterior spotting.

SECTIONAL NOTES

COLORADO

Colorado has experienced an unusually mild and dry spring. As a result, potato plantings are earlier in most districts than usual with the result that the early districts should be marketing potatoes the last week in June. There has been a slight tendency on the part of growers to increase plantings as a result of favorable prices last year.

The outlook for water for irrigation is unfavorable in most districts, as the winter snowfall was very light. Unless an unusually wet summer is experienced the size of the crop is apt to be somewhat small.

A general outbreak of psyllid yellows seems probable as a result of favorable weather conditions, and the fact that these insects are more numerous than usual in Arizona and New Mexico.

The largest crop of certified seed ever produced in the state has been sold and additional supplies have been obtained from other states. The best seed ever planted in the state is now going into the ground. Many growers have signified their intention of attempting to obtain membership in the 600-Bushel Club.—C. H. METZGER.

Early potato planting in the Greeley section is completed. It appears that a normal acreage has been planted. The early crop is composed chiefly of Irish Cobblers and Triumphs, although some early Ohios are planted.

In this section the early Ohio is harvested about ten days earlier than the Irish Cobbler; the Irish Cobbler ten to twelve days earlier than the Bliss Triumph.

Psyllid yellows, or "purple top" as the disease is termed in this section, has caused considerable damage to the early crop for the past three years. In some instances, fields have been a total failure because of this malady. It is too early to predict the amount of infestation that may be expected this year.

Mr. L. B. Daniels of the Entomology Department of the Colorado Agricultural College is endeavoring this year to keep track of psyllid migration by means of traps. Spraying experiments conducted by the Colorado Agricultural College indicate that lime-sulphur sprays are of particular value for killing psyllids and controlling psyllid yellows.

Last week meetings were held in different sections of the district and growers were given instructions on control measures. The speakers were Mr. L. B. Daniels of the Entomology Department and Mr. C. H. Metzger, Associate Horticulturist of the Colorado Agricultural College.

Most of the reservoirs in this section have sufficient water in storage to assure a good run of reservoir water for late irrigation. There is not, however, a normal amount of snow in the mountains, which may result in a short run of river water for early irrigation.—W. C. EDMUNDSON.

IDAHO

Until recently the prospects were that we would have a considerable increase in acreage in this state. However, since the potato market became unsatisfactory there has been less tendency to plant. In fact this has been quite noticeable in the market demands for our certified stock. Normally our certified potatoes move during March, April and May, but the demand for them during the past few weeks has been greatly reduced.

Our planting of late potatoes is, or should be, done during June. The Gem is possibly a little different from some other varieties in that if planted sufficiently early to start making tubers during the highest temperature period of summer, the product is likely to be off type.

It will be another month before we will really know what the planting situation will be in this state.—E. R. BENNETT.

MASSACHUSETTS

In the earlier sections where Cobblers predominate, planting operations are completed. General planting is over half completed throughout most of the state, but in the later hill sections planting is only just beginning.

Weather conditions have been fairly satisfactory. In general some increase in acreage over 1933 appears probable, particularly in the tobacco area of the Connecticut Valley. In addition to car lot shipments of seed arriving by rail, considerable trucked in seed is arriving from Vermont.—R. W. DONALDSON.

OHIO

It looks like another dry season for Ohio. Since January 1, there has been a deficiency of moisture of 7.46 inches to date (May 9). The weather remained cool until about the first of May when it then turned warm and the temperature since then has been above normal. The early potato crop was planted about the regular time but the soil is now so dry that there has been little growth. The late crop is now being planted.

The acreage in Ohio has been reduced about two per cent. This reduction no doubt, is due to many small farmers discontinuing potato production. Last year, general farmers were looking for a cash crop and many planted potatoes. The season was so dry and hot that many of the growers did not any more than get their seed back. Most of the reduction in acreage is coming from this type of growers. However, some of the larger commercial growers are reducing their acreage somewhat.—E. B. TUSSING.

PENNSYLVANIA

Our crop estimate gives Pennsylvania 99% of last year's acreage. If there is any reduction, which is doubtful in my mind, it is due to the high price of seed. So far as I can learn, local seed stocks have been pretty well cleaned up. Some local seed was frosted in cellars. There have been a few cases of netting and internal discoloration of stock held for seed, apparently due to lack of ventilation in over filled storages during the continued cold spell in February. Much inferior seed will no doubt be planted.

The acreage of Cobblers has been increased again this year, judging from the importation of Cobbler seed. There has been some difficulty in getting early potatoes planted due to the cold wet weather in April. For the past three weeks the western half of the state has been very dry, making plowing increasingly difficult. This condition was relieved by showers in some sections during the week of May 6th. Moisture in the eastern counties has been adequate. Planting of late potatoes is just getting well under way.—J. B. R. DICKEY.

INDIANA

We do not have a very large acreage of early potatoes, however, they are coming up nicely. There is quite a bit of difference in the unsprayed or undusted patches from the flea beetle. Our growing conditions have been excellent so far with sufficient moisture. I believe that the increase in early potaotes in our state will run about 2% more than in years past. The late potato crop will not be planted until the latter part of this month and planting will continue until the middle or latter part of July, which will run about the same as usual. We will be needing rain in the next week or ten days for best development of the potatoes.—W. B. WARD.

CALIFORNIA

The potato crop in the Los Angeles area and area south, is about the same as last year, however, the harvesting of these crops is about three weeks ahead of last year and have been daily heavier than last year. These Los Angeles potatoes will be used gradually during May, June and July. They will be used locally for the most part and rarely ever enter into the out-of-state movement, however, they do condition the movement from California in that the quantity of potatoes used in Southern California from Shafter depends on the quantity produced in Los Angeles.

In the Shafter District the arreage is greater this year than last but the prospects of yield are not so uniformly good this year. The growth of the vines is three weeks ahead of last year but as there is quite a large margin at the time of harvest, it is impossible at the present time to estimate the total yields. The total quantity will depend very largely on the demand, but it is quite safe to assume that with the increased acreage, the total quantity produced in the Shafter District this year will likely be greater than last year.

In the Stockton District, for the most part, the plantings are quite late. There will be no increase in acreage and it is quite impossible at the present time to estimate quantities. There will be a limited quantity of potatoes ready to move from the Stockton District about July 1st. Even with the late planting, the quantity available in July will be sufficient to take care of consumptive demands but it will likely not be excessive.

California will have available for shipment out of California during June and July, about 500 carloads of very fine quality potatoes. —H. G ZUCKERMAN.

The condition of the potato crop in southern California (Los Angeles, Riverside and San Bernardino counties) is considerably below normal. Except for sub-normal rainfall, weather conditions apparently have been favorable but almost all growers report below average condition. The production per acre of early sections that are being harvested now are reported as from 50 per cent to 75 per cent normal. The later sections probably will do better but relatively light yields are to be expected. It is quite probable that the slight increase in acreage in these three counties for 1934 will be more than offset by the decrease in production per acre and that the total production for 1934 will be somewhat less than that of 1933.—J. G. MCSWEENY.

VIRGINIA

The Cape Charles district, producing one-third of the Eastern Shore potato crop, has approximately the same acreage this years as in 1933. This area has good crop prospects, with good stand and nice uniform growth, although the plants are somewhat smaller than normal at this season of the year.

The middle area of the Peninsula, extending from Machipongo to Bloxom, producing normally fifty per cent of the crop, has increased acreage from six to ten per cent, but has suffered loss from cold and floods estimated to be from twenty to thirty per cent of the acreage planted.

The northern part of the Eastern Shore of Virginia, extending from Bloxom to Franklin City, Virginia, increased its acreage perhaps ten per cent, with crop scarcely far enough advanced to indicate true conditions as to stand. Undoubtedly, however, there is some loss from the same causes but not so great as existed in the central area.

Based on figures from the Agricultural Credit Association and our own Supply Subsidiary, the Eastern Shore Farmers' Supply Company, the acreage increase on the Eastern Shore of Virginia would not exceed ten per cent and probably less, with the loss now estimated to exceed increased acreage by a considerable margin.—G. S. RALSTON.

SOUTH CAROLINA

I was in the potato district yesterday, and find that the crop is beginning to suffer from a lack of moisture, and unless there are showers during the next few days the growers and shippers believe that yields will be reduced considerably.

Movement is expected to get under way the first of next week, and probably will not be heavy until the week of May 21-26.—GEO. E. PRINCE.

NORTH CAROLINA

The early part of this week I took a trip through the Mount Olive section of this state, which is a large early Irish potato growing section. The crop there seems to have come up to a good stand in most fields and I would say that, barring drought conditions, the crop will be a large one. I have also heard reports from some of the other potato growing sections of the eastern part of the state to the effect that the crop is looking very good. I do believe that possibly the

harvest will be a few days later than usual on account of our late spring, but from present appearances I would say that the crop will be as heavy as was predicted early in the year. The cold weather does not seem to have done any damage to the planted crop.—ROBERT SCHMIDT.

HAYTI

Our experiments with the potato crop this year were planted with seed purchased from New York. The experiment, which was planted on April 12, is being conducted largely to determine the value of certain fertilizer treatments. The cut surfaces of the seed were rubbed in charcoal just before planting. We hope to harvest the present crop in July and plant a second crop in August to determine the possibility of using home grown seed for this purpose. This is necessary since it costs us approximately $5.00 a bushel for imported seed potatoes. In this connection I would suggest that seed potatoes should be packed in barrels rather than sacks for foreign shipment to avoid losses from handling.—LOUIS DEJOIE.

IOWA

A serious moisture deficiency, accompanied by high winds and severe dust storms, is characteristic of this season's weather in Iowa. To date there is a deficiency of 13 inches, or upwards of 35 per cent over the corresponding date from one year ago. Tons of earth have been transported by dust storms and it is hard to tell whether Nebraska has lost to Iowa or whether we are moving over into Illinois.

On the other hand, the soil has worked up in excellent condition and the schedule of spring work is well advanced. The planting of the commercial acreage on the muck areas is well advanced and all we need is a real rain.—A. T. ERWIN.

ARKANSAS

Present conditions indicate a good crop in prospect in all sections of the State. Where home grown seed or low grade northern seed was used there are poor stands. Through most of the southern section the crop will be at least one week late. In the Fort Smith area considerable tip and margin injury is showing up.

Improved marketing arrangements should give better returns especially in the Coastal Plain section.

Our acreage is not so heavy as earlier reports would indicate, however, shipments may be larger than last year, since yield prospects are better. The indicated increase in acreage of all truck crops did not materialize, partly due to a large peach crop in prospect in many sections where truck crops are grown in years of a peach crop failure. —Wm. G. Amstein.

NEW YORK

Potato planting will be later than usual this year. While the Long Island acreage is now in, most of it was planted 10 days to two weeks late. Plantings on muck are now completed (May 15th) and the acreage will probably show an increase. The main crop acreage upstate will be planted late on account of the late spring and the extremely dry weather which has interfered with spring plowing and seeding of spring grain crops. There will be apparently little change in acreage from last year. The out of state demand for Cobbler and Green Mountain seed was good, while the sales of Rural seed for local use have been disappointing. The latter is due to the disparity in price between table stock and certified seed.

Dr. K. H. Fernow is now planting the 100 tuber samples required from prospective growers of certified seed. These are inspected early to determine which lots are eligible for inspection on the growers' farms later in the season. Two important changes have been made in the certification standard this year, one concerning eligibility, the other concerning grading. Beginning in 1935, "fields planted on land on which potatoes were grown the previous year will not be accepted for inspection." This change is based on the fact that in such cases, volunteer plants carrying virus have proved to be a potent factor in the spread of disease. All seed shall be sold and delivered graded as U. S. No. 1 or better, provided that the maximum size shall not exceed 12 ounces, unless a written agreement is entered into between buyer and seller definitely stipulating any other U. S. grade.

The annual summer field day of the Empire State Potato Club will be held on the farm of H .L. Hodnett & Sons, Fillmore, Alleghany County, New York, on or about August 9th. Mr. Hodnett is well known as a grower of certified Rural and Rural Russet certified seed. Earl Foster, Belmont, N. Y., Alleghany County Agent, is general chairman of the arrangements committee. Demonstration plots on virous diseases, new and standard varieties, twin-row planting, etc., will be planted for this occasion soon.—E. V. Hardenburg.

THE PRICE SITUATION

The following report on potatoes was released on May 15 by the Bureau of Agricultural Economics of the United States Department of Agriculture.

Potato prices in market centers declined almost steadily during April and are now back to the levels of last December. They are, however, about double those of a year ago and continue to attract relatively large shipments of old stock potatoes from the Northern States more distant from market centers. Shipments of new potatoes are also moving at a slightly faster rate than at this time last year despite the fact that the movement from Alabama and Louisiana is late in getting started. With the prospect that production in all of the early states, except Texas, will be larger than a year ago, it is likely that market prices for both old and new stock will continue to decline during the next few weeks and if the intermediate crop is also large the price decline may extend into July. Prices for the early crop season, however, are likely to average slightly above those of last year.

At New York potato prices declined from $2.16 per 100 pound sack in the first week of April to $1.90 in the first week of May. A year ago they averaged only 99 cents. At Chicago the decline during April was from $1.64 to $1.22 per 100 pound-sack, while for the first week of May a year ago potato prices averaged 70 cents. The price declines during the past month were a continuation of the trend in March. Potato prices reached a peak in February and have been declining almost steadily since that time.

Shipping point prices have declined with market prices during the past month. Maine Green Mountains averaged $1.10 per 100 pound-sack at Presque Isle during the first week of May against $1.55 a month earlier and $2.00 two months earlier. At Rochester, New York, round whites averaged $1.31 per 100 pounds for the first week of May compared with $1.55 a month ago and $1.90, two months ago. Information regarding shipping point prices is not available since the market news offices in these states were closed in April. New potatoes at Hastings, Florida, were quoted at $2.31 per 100 pounds or about the same as a month ago.

The United States farm price of potatoes averaged 83.4 cents per bushel on April 15 compared with 92.0 cents on March 15; 42.4 cents on April 15, 1933 and 68.8 cents the 1910-1914 April average.

Shipments of both old and new stock potatoes are moving at a slightly faster rate than at this time a year ago. Owing to the peculiar distribution of the late crop in the Northern States the past season,

more old stock potatoes and a larger proportion of the crop have moved to market via rail or boat than in the 1932-33 season. The areas near the larger market centers had a short crop this year, while the more distant States such as Maine, Nebraska, North Dakota, Minnesota and Idaho had fairly large crops. The car-lot movement to date from the late Northern States totaled 152,000 cars to May 5 compared with 129,000 cars to May 6, 1933 and 139,000 cars the total movement from these states during the 1932-33 season.

Shipments from the early states this year through May 5 totaled 6100 cars compared with 5200 cars to May 6, 1933. The peak of the movement from Florida occurred in the week ending April 28 while the movement from Alabama and Louisiana is just getting started. South Carolina and Georgia are soon expected to begin shipping. All of these states have increased supplies of potatoes this year, but it is expected that since supplies of old stock are smaller and since demand conditions are somewhat improved over those of last year, prices are likely to average slightly higher in these states than they did in 1933.

REVIEW OF RECENT LITERATURE

Early potato culture, FILIMANOV, A. AND A. RUTSHKINA. (*Transactions of the Potato Scientific Research Institute U.S.S.R. Part I. pp.* 1-44, 1933.)

According to the authors the purpose of their investigations was to determine the best method or methods for the acceleration of tuber development, increasing yield and securing high table quality in early potato production.

The experiments were conducted on field plots manured at the rate of 18 to 36 tons per hectare (2.47 acres). The tubers were green-sprouted from 4 to 6 weeks in a warm and well lighted room before planting.

The conclusion in regard to the efficiency of the various methods was based upon growth curves obtained from periodical harvests at 10-day intervals from the beginning of flowering of the plants.

The following conclusions were based on the 1932 data in connection with that of previous years:

The green-sprouting of seed tubers hastened the tuber formation and increased the yield in the early harvestings.

Under the climatic conditions prevailing near Moscow green sprouted seed had no influence on final yield of the varieties tested. Farther north the green-sprouting of tubers increased the final yield.

A certain lengthening of the green-sprouting period was found to have a positive effect upon the rate of tuber formation and yield. The varieties Early Rose, Centenary and Epicure responded differently. The most acceptable duration was found to be between 28 and 42 days.

Removal of sprouts before planting materially decreased rate of tuber formation and yield in the first half of the growing season but had no influence on the final yield.

Application of phosphatic fertilizers increased the early yield of potatoes. The application of potassium decreased the yield. Highest yields were produced on plots receiving an application of phosphorus, nitrogen and potassium. Augmentation of phosphoric fertilizers from 60 to 90 kilograms per hectare hastened tuber formation and increased the percentage of marketable tubers.

The use of large seed tubers weighing from 70 to 100 grams (2.47 to 3.53 ozs.) increased the yield of early potatoes.

Varieties most sensitive to green sprouting showed greatest response from large tubers, but the use of large tubers did not prove a substitute for green sprouting.

Maximum yields were obtained from a combination of all methods, —green sprouting of large tubers, close planting and application of artificial fertilizers.—WM. STUART.

The toxicity of formaldehyde and mercuric chloride solutions on various sizes of Rhizoctonia solani, G. B. SANFORD and G. W. MARRITT *(Phytopathology, Vol. 23 (1933), No. 3, pp. 271-280, fig. 1).* —The authors state that in determining the effectiveness of any seed disinfectant the size of the sclerotia is as important as time of immersion or strength of the solution. The proportion of small, medium and large size sclerotial bodies was found to be roughly 13:3:1.

Formaldehyde used at a concentration of 1-240 for 2 hours is not effective for treating tubers where medium and large sclerotia are to be killed and the treatment would not seem justified on any ground except when sclerotia are practically absent or limited to very thin scurf. Mercuric chloride, 1 to 834 for 1 hour was about as effective in killing the small and medium sizes as formaldehyde, strength 1-120 for 2 hours By addition of 1 per cent, by volume, of hydrochloric acid to a mercuric chloride solution, 1-500, effective results for practical purposes can be obtained in about 5 minutes, provided large or extra hard sclerotia are not abundant. Where small or medium sclerotia are concerned, the solution of either acidulated or non-acidulated mercuric chloride was effective up to the 5th successive treatment and, for practical purposes, probably up to the 8th by extending the time.

Weeds as possible carriers of leaf roll and rugose mosaic of potato, T. P. DYKSTRA *(Jour. Agr. Research, Vol.* 47 (1933), *No.* 1. *pp.* 17-32, *fig.* 8*)*.—The author points out that apparently healthy potatoes are regarded as healthy in commercial practice, but they harbor in masked condition a virous disease which has been called "latent virus." In addition, there is a vein-banding virus which alone causes very faint symptoms in susceptible host plants. When, however, the latter virus is inoculated into apparently healthy potato plants, but which carry the latent virus, typical rugose-mosaic symptoms result.

Inoculation tests demonstrated that rugose mosaic was transmitted by leaf mutation from potato to *Solanum villosum, Physalis* sp., tomato, and petunia. It was shown also that aphids *(Myzus persicae)* did not transmit the latent virus from apparently healthy potatoes to other solanaceous plants while they transmitted only the vein-banding virus to tomatoes from potatoes infected with rugose mosaic. It was found also that the western potato flea beetle, leafhopper, tarnished plant bug, spittle bug and *Nabis alternatus* did not transmit the latent virus of apparently healthy potatoes to jimson weed. On the other hand, insects naturally occurring on the potato can transmit leaf roll and rugose-mosaic from infected weeds to potato. It was also found that leaf roll was transmitted by aphids from potato to *Solanum villosum, S. dulcamara, Datura stramonium, D. tatula,* and *Lycopersicum esculentum.*

Normal growth of potato leaves in greenhouse and field, WINONA E. STONE *(Jour. Agr. Research, Vol.* 46, (1933), *No.* 6, *pp.* 565-578, *fig.* 9*)*.—Growth rates of potato leaves under optimum conditions of plant growth are reported. Measurements on rapidly growing leaflets taken in the morning and at night showed: in greenhouse plants, night growth, 54.1 per cent; day growth, 45.9 per cent: in outdoor plants, night growth, 56.8 per cent; day growth, 43.2 per cent. Rate of growth is not always the same for any single day; so growth seems to be more or less independent of environment. Young leaves grow slowly but as soon as they are established, they constantly use more food, partly of their own manufacture and partly that made by the older leaves. In this way the new leaves slow down the growth of the older ones. Checking in vegetative growth is not due to flower formation, for growth continues after flower clusters have appeared.

Psyllid yellows of the potato, B. L. RICHARDS and H. L. BLOOD *(Jour. Agr. Research, Vol.* 46 (1933), *No.* 3, *pp.* 189-216, *figs.* 7*)*.—This disease, first reported in 1927, has proven to be very serious in

parts of Utah and Colorado. It has also been reported from Idaho, Montana, Wyoming and California. In Utah in 1927, the early crop was practically a total failure and heavy losses were reported from Colorado. This disease is caused by the nymphs of the tomato psyllid *(Paratrioza cockerelli)*, the adult form of the insect apparently being incapable of producing yellows. Three to five nymphs to a plant might occasionally produce the disease but 15 to 30 actively feeding nymphs are usually necessary.

Under conditions of unmodified sunlight psyllid-yellows symptoms consist of yellowing, basal leaf rolling and purpling of the younger leaves, yellowing and rolling of the older leaves, nodal enlargement, increased axillary angle, aerial tubers and shoots, frequent rosetting, various apical growths, distortion and excess tuberization and inhibition of the rest period. Under conditions of decreased exposure and intensity of light, basal, marginal and interveinal yellowing become a constant feature of the disease.

Attempts to transmit pysllid yellows from diseased to healthy plants have failed. Under Utah conditions also, the disease does not appear to be transmitted from diseased plants to the following generation through the tuber. When the nymphs are allowed to feed for less than 16 days the plant shows a tendency to recover. This is not believed to be a virus disease but it is believed to be the result of some toxic substance which is produced in some way during the feeding process of the psyllid nymphs.

Culture of Phytophthora infestans, WILLARD CROSIER *(Phytopathology, Vol. 23 (1933), No. 9, pp. 713-720. Fig. 1).*—The author describes methods for culturing *Phytophthora infestans* in pure culture as well as on tubers and foliage. Establishment of the fungus proceeds most rapidly at temperatures of 9 to 24° C., with an optimum at 19 to 22° C. Sporulation occurs at a minimum of 3° C., and at a maximum of 26° C. Low temperatures prolong the viability of the sporangia and a high relative humidity is absolutely essential to preserve their viability. The optimum temperature for indirect germination of the sporangia is 12 to 13° C., and for direct germination is 24° C. Germination takes place only in the presence of water. Swarm spores may be maintained in a motile condition by holding the spore suspension at 3° C. A few of the swarm-spore germ tubes penetrate the host in 1½ to 3 hours, penetration proceeding most rapidly at 20 to 25° C. Most rapid spread of this disease in the field results when the temperature favors indirect germination of the sporangia.

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THE OUTLOOK

Present indications point to the fact that, unless the drought ruins the potato crop in some sections, all potato growers will suffer as a result of the increased plantings this year. Favorable weather the remainder of the season is likely to result in over production and attendant low prices.

Plans are already being suggested in different states to forestall the disastrous effects of a crop surplus. It is reported that the North Carolina growers have been asked to ship no second size potatoes until after July 4. It is reported also that the Federal authorities have been asked to purchase 3,000 cars of North Carolina potatoes for relief purposes. In Virginia some consideration is being given to the possibility of purchasing 1,500 cars of bulk potatoes to be held in storage until early fall. The New Jersey growers have completed plans for a marketing organization similar to the one which proved to be so successful in 1933. In Maine, the growers are showing interest in the possibility of organizing under the A.A.A. In still other states various plans to improve conditions are under consideration.

These widely different attempts to stabilize the industry arise from the fact that each section is concerned with its own salvation and is attempting to develop plans which appear to be applicable to its own conditions. This is the obvious thing to do but it is hardly a sound procedure. No section can control the potato market and it is important therefore that, if we are to find a solution of our difficulties, sectional lines must be forgotten.

The present outlook is not encouraging. We have only to recall the 1932 season to realize the misery a year of low prices brings to the potato growers. Must we await the smash-up before we act to prevent a recurrence of this? It would be best to develop a plan now. If the potato industry could present a united front with regards to a plan, every grower would benefit.